

State of the Art (SOTA)
Manual for the Graphic Arts Industry

July 1997

State of New Jersey
Department of Environmental Protection
Air Quality Permitting Program

State of the Art (SOTA)
Manual for the Graphic Arts Industry
Section 3.17

Table of Contents

<u>Section</u>	<u>Page Number</u>
3.17.i Tables.....	3.17 - 3
3.17.ii Abbreviations	3.17 - 4
3.17: SOTA Manual for the Graphic Arts Industry	3.17 - 5
3.17.1: Scope	3.17 - 5
3.17.2: SOTA Performance Levels.....	3.17 - 6
3.17.3: Technical Basis and References	3.17 - 12
3.17.4: Recommended Review Schedule.....	3.17 - 12
3.17.5: References.....	3.17 - 12

3.17.1 Tables

Table	Page Number
-------	-------------

Table 1	State of the Art Performance Levels for Printing and Graphic Arts 3.17 - 7
---------	--

3.17.ii ABBREVIATIONS

<i>ACT</i>	Alternative Control Techniques
<i>BAAQMD</i>	Bay Area Air Quality Management District
<i>BACT</i>	Best Available Control Technology
<i>BTS</i>	Bureau of Technical Services
<i>CE</i>	Cost Effectiveness
<i>CFR</i>	Code of Federal Regulations
<i>CO</i>	Carbon Monoxide
<i>DOE</i>	Department of Energy
<i>DRE</i>	Destruction or Removal Efficiency
<i>HAP</i>	Hazardous Air Pollutant
<i>EPA</i>	Environmental Protection Agency
<i>LAER</i>	Lowest Achievable Emission Rate
<i>MACT</i>	Maximum Achievable Control Technology
<i>MSDS</i>	Material Safety Data Sheet
<i>NJAC</i>	New Jersey Administrative Code
<i>NJDEP</i>	New Jersey Department of Environmental Protection
<i>NSPS</i>	New Source Performance Standard
<i>ppm</i>	parts per million
<i>PSD</i>	Prevention of Significant Deterioration
<i>RACT</i>	Reasonably Available Control Technology
<i>SCAQMD</i>	South Coast Air Quality Management District
<i>THC</i>	Total Hydrocarbon Compounds
<i>TSP</i>	Particulate Matter
<i>TXS</i>	Toxic Substance
<i>US EPA</i>	United States Environmental Protection Agency
<i>UV</i>	Ultraviolet
<i>VOC</i>	Volatile Organic Compound

3.17 SOTA MANUAL FOR THE GRAPHIC ARTS INDUSTRY

3.17.1. Scope

The SOTA performance levels included in this manual apply to all types of graphic arts technologies. Graphic arts means the application of text and/or images to a substrate via lithographic, screen, rotogravure, flexographic, letterpress, or printing process including any related coating or laminating operations. Important terms related to graphic arts are:

Lithographic Printing - A planographic printing system where the image and nonimage areas are chemically differentiated. The image area is oil receptive and nonimage area is water receptive. Ink film from the lithographic plate is transferred to an intermediary surface (blanket), which, in turn, transfers the ink film to the substrate. Fountain solution is applied to maintain the hydrophilic properties of the nonimage area. Ink drying is divided into heatset and nonheatset.

Fountain Solution - A mixture of water and other volatile and non-volatile chemicals and additives that maintains the quality of the printing plate reduces the surface tension of the water so that it spreads easily across the printing plate surface. The fountain solution wets the nonimage area so that the ink is maintained within the image areas. Non-volatile additives include mineral salts and hydrophilic gums. Alcohol and alcohol substitutes, including isopropyl alcohol, glycol ethers, and ethylene glycol, are the most common VOC additives used to reduce the surface tension of the fountain solution.

Heatset - A lithographic web printing process where heat is used to evaporate ink oils from the printing ink. Heatset dryers (typically hot air) are used to deliver the heat to the printed web.

Non-Heatset - A lithographic printing process where the printing inks are set without the use of heat. Traditional non-heatset inks set and dry by absorption and/or oxidation of the ink oils. Ultraviolet-cured and electron beam-cured inks are considered non-heatset although radiant energy is required to cure these inks.

Flexographic Printing - A printing system using a flexible rubber or elastomeric image carrier in which the image area is raised relative to the nonimage area. The image is transferred to the substrate through first applying ink to a smooth roller which in turn rolls the ink onto the raised pattern of a rubber or elastomeric pad fastened around a second roller which then rolls the ink onto the substrate.

Rotogravure Printing - A printing system using a chrome plated cylinder where the image area is recessed relative to the nonimage area. Images are transferred onto a substrate through first applying ink to a cylinder into the surface of which small, shallow cells have been etched forming a pattern, then wiping the lands between the cells free of ink with a doctor blade, and finally rolling the substrate over the cylinder so that the surface of the substrate is pressed into the cells, transferring the ink to the substrate.

Screen Printing - A printing system where the printing ink passes through a web or fabric to which a refined form of stencil has been applied. The stencil openings determine the form and dimensions of the imprint.

Letterpress Printing - A printing system in which the image area is raised relative to the nonimage area and the ink is transferred to the substrate directly from the image surface.

3.17.2. SOTA Performance Levels

State of the Art (SOTA) performance levels are given in Table 1. SOTA consists of either add-on controls or the use of reformulated inks, coatings, and adhesives (i.e., pollution prevention).

If reformulated inks, coatings, and adhesives that meet these performance levels are used, no add-on controls are required except as indicated below. (Limits on the VOC content of inks, coatings, and adhesives are on an as-applied basis.) If add-on controls are used, the destruction or removal efficiencies (DREs) and capture efficiencies specified must be met. (NJDEP considers a thermal oxidizer to be designed for 99 percent DRE if the temperature is 1,500°F or greater and the residence time is 0.5 seconds or longer. A case-by-case demonstration that units designed with lower temperatures can achieve a 99 percent DRE may be submitted to the Department for consideration.) There are no limits on the VOC content of the inks, coatings, and adhesives used when add-on controls are used to achieve SOTA. For other printing technologies, SOTA consists solely of limits on the VOC content of inks, coatings, fountain solutions, and adhesives. If the SOTA performance levels in Table 1 cannot be met by an applicant, the applicant must submit a case-by-case SOTA demonstration. If an applicant proposes to use materials meeting the performance levels in Table 1 and the emissions from the source will exceed 25 tons per year with controls, a case by case analysis must be submitted to further reduce emissions using pollution control or add-on control technologies.

It is recognized that demonstrating control efficiencies may be difficult in some cases because of potential uncertainties in test methods. The use of a particular test method must be approved in advance by NJDEP's Bureau of Technical Services (BTS). In general, Method 25 is used when the outlet concentration is expected to be 50 ppm or greater. For actual or expected VOC outlet concentrations below 50 ppm, Method 25A is used. For some printing technologies such as heatset offset lithography, there may be a problem caused by condensation of VOCs which makes it difficult to conduct Method 25 tests. To resolve such problems, companies must propose a test protocol to BTS for approval.

Table 1
State of the Art Performance Levels for Printing and Graphic Arts

Printing and Graphic Arts Industry	
<i>Printing or Graphic Arts Type</i>	<i>Performance Level</i>
Flexographic printing	
Publication	
Sheet-fed and Web-fed	<p>With Pollution Prevention:</p> <p>Ink - ≤ 1.5 lbs VOC/gal less H₂O Coating - ≤ 1.5 lbs VOC/gal less H₂O Adhesive - ≤ 1.25 lbs VOC/gal less H₂O</p> <p>With Add On Controls:</p> <p>Capture Efficiency: 100 percent (as prescribed by EPA Test Method 204) DRE for Oxidizers: 99 percent design and 95 percent demonstrated or outlet VOC concentration ≤ 20 ppmv dry (excluding methane) DRE for Other Types of Control Devices: 95 percent or outlet VOC concentration ≤ 20 ppmv dry (one hour average)</p>
Packaging	
Sheet-fed	<p>With Pollution Prevention:</p> <p>Ink - ≤ 1.5 lbs VOC/gal less H₂O Coating - ≤ 1.5 lbs VOC/gal less H₂O Adhesive - ≤ 1.25 lbs VOC/gal less H₂O</p> <p>With Add On Controls:</p> <p>Capture Efficiency: 100 percent (as prescribed by EPA Test Method 204) DRE for Oxidizers: 99 percent design and 95 percent demonstrated or outlet VOC concentration ≤ 20 ppmv dry (excluding methane) DRE for Other Types of Control Devices: 95 percent or outlet VOC concentration ≤ 20 ppmv dry (one hour average)</p>
Web-fed	<p>With Pollution Prevention:</p> <p>Ink - ≤ 1.5 lbs VOC/gal less H₂O Coating - ≤ 1.5 lbs VOC/gal less H₂O Adhesive - ≤ 1.25 lbs VOC/gal less H₂O</p> <p>With Add On Controls:</p> <p>Capture Efficiency: 100 percent (as prescribed by EPA Test Method 204) DRE for Oxidizers: 99 percent design and 95 percent demonstrated or outlet VOC concentration ≤ 20 ppmv dry (excluding methane) DRE for Other Types of Control Devices: 95 percent or outlet VOC concentration ≤ 20 ppmv dry (one hour average)</p>

Printing and Graphic Arts Industry	
<i>Printing or Graphic Arts Type</i>	<i>Performance Level</i>
Wide web	
Web-fed	<p>For HAPs:</p> <p>Compliance with the control technology requirements in the Printing and Publishing Industry MACT (40 CFR 63, Subpart KK) by sources subject to the MACT and by those sources that are not subject is SOTA for HAPs.</p> <p>For VOCs:</p> <p>Ink - ≤ 1.5 lbs VOC/gal less H₂O Coating - ≤ 1.5 lbs VOC/gal less H₂O Adhesive - ≤ 1.25 lbs VOC/gal less H₂O</p> <p>With Add On Controls:</p> <p>Capture Efficiency: 100 percent (as prescribed by EPA Test Method 204) DRE for Oxidizers: 99 percent design and 95 percent demonstrated or outlet VOC concentration ≤ 20 ppmv dry (excluding methane) DRE for Other Types of Control Devices: 95 percent or outlet VOC concentration ≤ 20 ppmv dry (one hour average)</p>
Offset Lithography (Non-Heatset)	
Sheet-fed	<p>Inks and varnish - No level. Coating - ≤ 2.5 lbs VOC/gal less H₂O Fountain Solution - $\leq 5.0\%$ VOC by weight (no alcohol) or Fountain Solution - $\leq 8.5\%$ VOC by weight (alcohol) and Chiller Temperature $\leq 60^{\circ}\text{F}$</p> <p>For Folding Box Manufacture:</p> <p>Adhesive - ≤ 1.25 lbs VOC/gal less H₂O (Used on gluing lines. Not applied on the press.)</p>
Web-fed	<p>Inks - No level. Fountain solution - $\leq 5.0\%$ VOC by weight (No alcohol) Cleaning - $\leq 30.0\%$ VOC by weight or 100% VOC by weight if VOC composite vapor pressure ≤ 10 mm Hg at 20°C (68°F) Coating - ≤ 2.5 lbs VOC/gal less H₂O</p>
Offset Lithography (Heatset)	
Web-fed	<p>Add-on controls with the following performance levels: Capture Efficiency: 100 percent (If no in-line finishing is performed, the use of add-on controls on the dryer exhaust is considered 100 percent capture.) DRE for Oxidizers: 99 percent design and 95 percent demonstrated or outlet VOC concentration ≤ 20 ppmv (excluding methane)</p>

Printing and Graphic Arts Industry	
<i>Printing or Graphic Arts Type</i>	<i>Performance Level</i>
	<p>DRE for Other Types of Control Devices: 95 percent or outlet VOC concentration \leq 20 ppmv Coating - \leq 2.5 lbs VOC/gal less H₂O Fountain Solution - \leq 1.6% VOC by weight; or \leq 3.0% VOC by weight with Chiller Temperature \leq 60°F; or \leq 5.0% VOC by weight if no alcohol is used.</p> <p>If in-line finishing (post dryer) is used, emissions must be controlled by one of the following:</p> <ol style="list-style-type: none"> 1) Average VOC content limit of 2.5 lbs/gal VOC (less water) for coating and other in-line finishing materials, or 2) Capture and control system achieving 100 percent capture of the emissions and using add-on controls with the specifications listed above for oxidizers or other types of control devices.
Letterpress Printing	
Sheet-fed and Web-fed	<p>Inks and varnish - No level. Coating - \leq 2.5 lbs VOC/gal less H₂O</p>
Gravure Printing	
Publications	
Web-fed	<p>For HAPs:</p> <p>Compliance with the control technology requirements in the Printing and Publishing Industry MACT (40 CFR 63, Subpart KK) by sources subject to the MACT and by those sources that are not subject is SOTA for HAPs.</p> <p>For VOCs:</p> <p>Ink - \leq 1.5 lbs VOC/gal less H₂O Coating - \leq 1.5 lbs VOC/gal less H₂O Adhesive - \leq 1.25 lbs VOC/gal less H₂O</p> <p>If reformulated inks, coatings, and adhesives that meet the specifications above cannot be used; add-on controls with the following performance levels:</p> <p>Capture Efficiency: 100 percent (as prescribed by EPA Test Method 204) DRE for Oxidizers: 99 percent design and 95 percent demonstrated or outlet VOC concentration \leq 20 ppmv (excluding methane) DRE for Other Types of Control Devices: 95 percent or outlet VOC concentration \leq 20 ppmv</p>
Packaging	

Printing and Graphic Arts Industry	
<i>Printing or Graphic Arts Type</i>	<i>Performance Level</i>
Sheet-fed	<p>For HAPs:</p> <p>Compliance with the control technology requirements in the Printing and Publishing Industry MACT (40 CFR 63, Subpart KK) by sources subject to the MACT and by those sources that are not subject is SOTA for HAPs.</p> <p>For VOCs:</p> <p>Ink - ≤ 1.5 lbs VOC/gal less H₂O Coating - ≤ 1.5 lbs VOC/gal less H₂O Adhesive - ≤ 1.25 lbs VOC/gal less H₂O</p> <p>If reformulated inks, coatings, and adhesives that meet the specifications above cannot be used; add-on controls with the following performance levels:</p> <p>Capture Efficiency: 100 percent (as prescribed by EPA Test Method 204) DRE for Oxidizers: 99 percent design and 95 percent demonstrated or outlet VOC concentration ≤ 20 ppmv (excluding methane) DRE for Other Types of Control Devices: 95 percent or outlet VOC concentration ≤ 20 ppmv</p>
Web-fed	<p>For HAPs:</p> <p>Compliance with the control technology requirements in the Printing and Publishing Industry MACT (40 CFR 63, Subpart KK) by sources subject to the MACT and by those sources that are not subject is SOTA for HAPs.</p> <p>For VOCs:</p> <p>Ink - ≤ 1.5 lbs VOC/gal less H₂O Coating - ≤ 1.5 lbs VOC/gal less H₂O Adhesive - ≤ 1.25 lbs VOC/gal less H₂O</p> <p>If reformulated inks, coatings, and adhesives that meet the specifications above cannot be used; add-on controls with the following performance levels:</p> <p>Capture Efficiency: 100 percent (as prescribed by EPA Test Method 204) DRE for Oxidizers: 99 percent design and 95 percent demonstrated or outlet VOC concentration ≤ 20 ppmv (excluding methane) DRE for Other Types of Control Devices: 95 percent or outlet VOC concentration ≤ 20 ppmv</p>

Printing and Graphic Arts Industry	
<i>Printing or Graphic Arts Type</i>	<i>Performance Level</i>
Product	
Sheet-fed	<p>For HAPs: Compliance with the control technology requirements in the Printing and Publishing Industry MACT (40 CFR 63, Subpart KK) by sources subject to the MACT and by those sources that are not subject is SOTA for HAPs.</p> <p>For VOCs: Ink - ≤ 1.5 lbs VOC/gal less H₂O Coating - ≤ 1.5 lbs VOC/gal less H₂O Adhesive - ≤ 1.25 lbs VOC/gal less H₂O</p> <p>If reformulated inks, coatings, and adhesives that meet the specifications above cannot be used; add-on controls with the following performance levels:</p> <p>Capture Efficiency: 100 percent (as prescribed by EPA Test Method 204) DRE for Oxidizers: 99 percent design and 95 percent demonstrated or outlet VOC concentration ≤ 20 ppmv (excluding methane) DRE for Other Types of Control Devices: 95 percent or outlet VOC concentration ≤ 20 ppmv</p>
Web-fed	<p>For HAPs: Compliance with the control technology requirements in the Printing and Publishing Industry MACT (40 CFR 63, Subpart KK) by sources subject to the MACT and by those sources that are not subject is SOTA for HAPs.</p> <p>For VOCs: Ink - ≤ 1.5 lbs VOC/gal less H₂O Coating - ≤ 1.5 lbs VOC/gal less H₂O Adhesive - ≤ 1.25 lbs VOC/gal less H₂O</p> <p>If reformulated inks, coatings, and adhesives that meet the specifications above cannot be used; add-on controls with the following performance levels:</p> <p>Capture Efficiency: 100 percent (as prescribed by EPA Test Method 204) DRE for Oxidizers: 99 percent design and 95 percent demonstrated or outlet VOC concentration ≤ 20 ppmv (excluding methane) DRE for Other Types of Control Devices: 95 percent or outlet VOC concentration ≤ 20 ppmv</p>
Screen Printing	
Sheet-fed and Web-fed	<p>Fabric - ≤ 2.9 lbs VOC/gal less H₂O Ink ≤ 3.3 lb VOC/gal less H₂O Metallic ink ≤ 3.3 lb VOC/gal less H₂O Coating ≤ 3.3 lb VOC/gal less H₂O Adhesive ≤ 3.3 lb VOC/gal less H₂O Extreme performance ink/coating ≤ 6.7 lb VOC/gal less H₂O</p>

3.17.3. Technical Basis and References

To define SOTA performance levels for printing and graphic arts, levels are developed from emission limitations that are being met by working sources, from permits issued by the New Jersey Department of Environmental Protection, New Jersey's VOC RACT rules (N.J.A.C. 7:27-16), California's VOC RACT rules, guidance from the USEPA BACT/LAER Control Technologies Database, National Emission Standards for Hazardous Air Pollutants (40 CFR 63), and the SCAQMD BACT Guidelines. Additional guidance was received during discussions with state environmental protection agencies in Oregon, Texas, Illinois, Michigan, South Carolina, and Wisconsin.

3.17.4. Recommended Review Schedule

The recommended review schedule is every two years for the following reasons.

- The graphic arts industry in New Jersey is an industry that has experienced much growth during the past few years.
- New technologies in inks, coatings, adhesives, and control equipment uses are being rapidly developed and demonstrated throughout the nation.
- States are becoming more innovative in their goal of meeting SIP plan requirements under the Clean Air Act Amendments of 1990. As a result, cost effective permitted requirements in nonattainment areas will continue to trend toward more control of VOC emissions.

3.17.5 References

Air & Waste Management Association, *Air Pollution Engineering Manual*, Van Nostrand Reinhold, 1992

Air Pollution Engineering Manual, Environmental Protection Agency, Office of Air and Water Systems, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, Second Edition, May, 1973.

Compilation of Air Pollutant Emission Factors: Volume I: AP-42, Fifth Edition, United States Environmental Protection Agency, Research Triangle Park, NC 27711, January, 1995

Robert A. Corbitt, *Standard Handbook of Environmental Engineering*, McGraw Hill, 1989.

Robert H. Perry and Don Green, *Perry's Chemical Engineers' Handbook*, Sixth Edition, McGraw Hill, 1973.

South Coast Air Quality Management District, *Best Available Control Technology Guideline, December 12, 1994.*

Technology Transfer Network, *RACT, BACT, LAER Clearing House*, United States Environmental Protection Agency, Research Triangle Park, NC 27711, August, 1996.

Beyond VOC RACT CTG Requirements, U. S. Environmental Protection Agency, Information Transfer and Program Interim Division, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, EPA-453/R-95-010, April 1995.

Graphic arts RACT rules for the following states: Colorado, Connecticut, Florida, Illinois, Michigan, New York, Oregon, Rhode Island, Maine, Texas, California Districts (Bay Area and South Coast Air Quality Management Districts).

Oregon Department of Environmental Quality, Mr. Greg Dahmen, phone conversation with Mr. Paul Grable, Pacific Environmental Services, Inc.

Texas Natural Resources Board, Mr. Eddy Mac, phone conversation with Mr. Paul Grable, Pacific Environmental Services, Inc.

Illinois Environmental Protection Agency, Mr. Darrine Clutch, phone conversation with Mr. Paul Grable, Pacific Environmental Services, Inc.

Michigan Department of Environmental Quality, Mr. Bob Irvine, phone conversation with Mr. Paul Grable, Pacific Environmental Services, Inc.

South Carolina Board of Health and Environmental Control, Ms. Florence Berry, phone conversation with Mr. Paul Grable, Pacific Environmental Services, Inc.

Wisconsin Natural Resources Board, Mr. Dan Johnson, phone conversation with Mr. Paul Grable, Pacific Environmental Services, Inc.